HW 3: Turing Machines

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1. A *Turing machine with left-reset* is similar to an ordinary Turing machine but the transition function has the form

   $\delta : Q \times \Gamma \to Q \times \Gamma \times \{R, RESET\}$

   The semantics of the $RESET$ move is that the Turing machine will go all the back to the left-most side of the tape, instead of just moving a step left. Prove that Turing machines with left reset are equivalent to ordinary Turing machines. To do this you'll need to

   - show that you can turn a Turing machine with left reset into an ordinary Turing machine (the hard part)
   - show that you can turn an ordinary Turing machine into a Turing machine with left reset (the easy part)

   The easiest way to do this is to simulate one type of movement with the other.

2. Show, by construction, that the Turing-decidable languages are closed under

   (a) union
   (b) intersection
   (c) complement

3. Give an informal description of the following languages

   - $\{w | w$ contains twice as many 0s as 1s$\}$
   - $\{w | w$ has matching parentheses and a length that's a power of 2$\}$

4. Show, by construction, that the Turing *recognizable* languages are closed under

- Kleene star
- concatenation
- reversal

Are the *recognizable* languages closed under complement? If not, can you give a counter-example?